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of inbreeding in brother  $\times$  sister mating is the same as for self-fertilization, save that it lags one generation behind the latter; thus the coefficient for the fourth generation of self-fertilization is the same as that for the fifth of brother  $\times$  sister mating. Pearl (1, p. 592) has already pointed out that in cousin mating the coefficient is one-half that for brother  $\times$  sister, with a lag of one generation; as compared with self-fertilization the lag is two generations. No such simple relation is apparent between the proportions of homozygotes resulting from the diverse methods of breeding, though possibly such may yet be discovered.

H. S. JENNINGS

#### PAPERS CITED

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2. ——. On the results of inbreeding a Mendelian population; a correction and extension of previous conclusions. This JOURNAL, XLVIII, January, 1914, pp. 57-62.
3. ——. On a general formula for the constitution of the  $n$ th generation of a Mendelian population in which all matings are of brother  $\times$  sister. This JOURNAL, XLVIII, August, 1914, pp. 491-494.
4. Jennings, H. S. Production of pure homozygotic organisms from heterozygotes by self-fertilization. This JOURNAL, XLVI, August, 1912, pp. 487-491.

#### A SHORT-CUT IN THE COMPUTATION OF CERTAIN PROBABLE ERRORS

IN his handbook of statistical methods, on p. 38, Dr. C. B. Davenport<sup>1</sup> gives a short method for the calculation of the probable errors of some of the commonest statistical constants, in a table of logarithmic formulæ. It would seem that the simple and obvious short-cut involved has not been given the attention it deserves in connection with non-logarithmic calculation. The logarithmic formulæ are as follows:<sup>2</sup>

$$(1) \log E_A = \log .6745 + \log \sigma - \frac{1}{2} \log n \left[ \text{since } E_A = .6745 \frac{\sigma}{\sqrt{n}} \right],$$

$$(2) \log E_\sigma = \log E_A - \frac{1}{2} \log 2 \left[ \text{since } E_\sigma = .6745 \frac{\sigma}{\sqrt{2n}}, \right.$$

$$\left. \text{or, } E_\sigma = E_A \div \sqrt{2} \right],$$

<sup>1</sup> Davenport, C. B., "Statistical Methods with Special Reference to Biological Variation," 2d ed., 1904, New York, John Wiley & Sons.

<sup>2</sup>  $A$  indicates the weighted arithmetic mean,  $\sigma$  the standard deviation, and  $C$  the coefficient of variability.

$$(3)^3 \quad \log E_c = \log E_\sigma - \log A \text{ [since } E_c = E_\sigma \div A].$$

Now, if one is working with a calculating machine, he can simply carry the value of  $E_A$  to two or three more decimal places than are to be retained, and then divide by the square root of 2 to get  $E_\sigma$ ; similarly, the latter value, divided by the mean, gives  $E_c$ .

The writer prefers, however, to calculate the values in the ordinary way on the machine, using Miss Gibson's<sup>4</sup> table for  $\frac{.6745}{\sqrt{n}}$  and  $\frac{.6745}{\sqrt{2n}}$ , and then to use the short method in checking.

The original computations can be indicated and performed with great confidence and rapidity, since it is hardly possible to make an error that will not be discovered in the checking.<sup>5</sup> It is obviously safer, as well as much quicker, to check in this way than to repeat the original processes.

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## GALTON AND DISCONTINUITY IN VARIATION

It seems not to be generally realized that Galton recognized both continuity and discontinuity, both in variation and inheritance. Of course, all biologists are familiar with "Galton's polygon," in which slight oscillations of the polygon on one of its faces, but without a change of face, are compared with "small unstable deviations" (fluctuations), while a larger oscillation, in which the polygon moves over to a new face, is compared to a sport . . . of such marked peculiarity and stability as to rank as a new type, capable of becoming the origin of a new race with very little assistance on the part of natural selection.<sup>1</sup>

Galton's polygon illustrated for him how the following conditions may co-exist:

(1) Variability within narrow limits without prejudice to the purity of the breed. (2) Partly stable sub-types. (3) Tendency, when much disturbed, to revert from a sub-type to an earlier form. (4) Occasional sports which may give rise to new types.

These four types would seem to correspond rather well to what

<sup>3</sup> Formula (3) gives, of course, the approximate or uncorrected value of  $E_c$ .

<sup>4</sup> Gibson, Winifred, "Tables for Facilitating the Computation of Probable Errors," *Biometrika*, 4: 385-393. 3 tables.

<sup>5</sup> Unless, of course, one misreads the figures from the machine in checking.

<sup>1</sup> "Natural Inheritance," London, 1889, p. 28.